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*MODERN SCIENTIFIC VIEWS OF THE CAUSE AND
PREVENTION OF ASIATIC CHOLERA.*

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THE first requisite for intelligent action is precise knowledge. Before we can deal wisely with a disease we must know what it is and how it acts. It is for these reasons that we must inquire, What, precisely, is Asiatic cholera, and how is it disseminated? Then, and then only, shall we be prepared to consider the means to be adopted for its prevention or suppression.

Asiatic cholera, according to the best knowledge of to-day, is a very active fermentation of the intestinal contents of man by a specific living ferment known as the *Spirillum* or *Bacillus* of Asiatic cholera. This fermentation differs from all other known fermentations of the intestinal contents in its activity and in its peculiarly destructive effects upon the individual. From the biological point of view it closely resembles the fermentation which occurs in typhoid fever, but it differs from that of typhoid fever very much as an explosion of dynamite differs from an explosion of gunpowder: it is more rapid, more violent, more fatal. The fermentation of the contents of the alimentary canal by a microorganism might be accompanied—as in the digestive processes of every-day life it unquestionably often is accompanied—by the formation of products harmless and even useful to the animal economy. But it appears to be the distinctive characteristic of the specific organism of Asiatic cholera that the fermentation to which it gives rise is accompanied by the development of products peculiarly poisonous to the human body—poisons which, absorbed into the body, upset the nervous system, producing vomiting, cramps and collapse; and in a very large proportion of cases produce death.

To make it clear what a disease of this kind really is the analogy is often used, and is just, of the fermentation of apple juice by the microorganism known as yeast. Under the influence of this specific



ferment innocuous apple juice is changed, so that it contains a small quantity of a poisonous substance, alcohol. If it contained a great quantity of alcohol, or if alcohol were a much more poisonous substance than it is, fermented apple juice would act upon the body as a violent poison.

So far as we know at present cholera cannot be produced without its specific ferment or germ, precisely as cider cannot be made without yeast or oaks spring up except from acorns. No matter how fertile the soil may be, the seed must be sown before the crop can appear. To suppose that cholera can arise without its germ is to assume the truth of spontaneous generation — one of the out-worn creeds of scientific history.

It is not necessary for our present purposes to consider at length the particular character of the organism of cholera. It is now generally believed that the curved bacillus or spirillum discovered by Koch, and known as the "comma bacillus," is the one and only cause of Asiatic cholera. But whether this be the case or not, there can be no question that cholera is a fermentative disease produced by a specific living microörganism, and for the purposes of practical sanitation this is sufficient. To enter upon an elaborate description of the organism or a history of cholera in the Middle Ages would be interesting, but it could not instruct us in modern scientific sanitation, which for its basis rests upon discoveries made since our civil war. To follow cholera in its rôle as a haunting spectre of unclean Orientals on filthy pilgrimages, is certainly impressive and not without its lesson; but the man-eating tiger is not to be feared in America as he is in India, and we may as reasonably hope to control the cholera from Calcutta as the tiger from Bengal.

If one wishes to have a fairly accurate idea of the germs of Asiatic cholera he has only to recall the chains of sausages which hang in butchers' windows. Enormously magnified and seen at a little distance the chain, with its curved links of sausages, well represents the growing groups of comma spirilla. Each individual sausage, moreover, well represents one germ or spirillum. Like the sausage the spirillum has a delicate skin or cell wall. Like the sausage the spirillum contains a substance of unknown composition. But unlike the sausage the spirillum is a living organism, and is able to reproduce itself.

We may now inquire how, precisely, is cholera disseminated. If what has been said above is true it is obvious that the principal and

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prolific source of cholera seed must be the contents of the alimentary canal; and exactly as a little leaven may leaven the whole lump the contents of one intestine may theoretically suffice to sow a thousand crops. Whether a single germ can or can not convey the disease we do not know. The probability is that under favorable conditions it might do so, but it is doubtful if, as a fact, it ever does. But in any case the seed must enter the body; and inasmuch as the body is virtually hermetically sealed in a germ-tight skin the germ must enter the mouth. Even supposing the skin to be broken it is at least doubtful if the germs could find effective entrance along that road. The only important avenue of entrance is unquestionably the mouth—using the word in its embryological sense and including the nose as a part of the mouth and as an avenue for dust. Whether the germs of cholera thrive or do not thrive outside of the human body they must still find entrance to the alimentary canal chiefly, and probably exclusively, through the mouth. We have then simply to consider in what ways the germs of cholera may be carried to the mouth.

Here we may get much help from a careful study of the facts of infection in a closely related disease with which we are much more familiar. I refer to typhoid fever; and, as I propose to draw largely upon our established knowledge of typhoid fever to offset our ignorant and foolish alarm about cholera, I may be permitted to say that while, in common with most Americans of my age, I have had no personal experience with epidemics of cholera I have had, within the past two years, a considerable experience with epidemics of typhoid fever, having superintended for the State Board of Health and others the investigation of seven important outbreaks of this disease in Massachusetts.

Typhoid fever, like Asiatic cholera, is a diarrhoeal disease; like cholera it affects the alimentary contents by a peculiar fermentation; but it is to cholera as gunpowder is to dynamite—slower, less violent, less fatal. It is almost absolutely certain that both diseases—typhoid fever and Asiatic cholera—are disseminated chiefly through the faecal discharges. We have already seen that the germs of cholera must enter the body through the mouth; the same is true of typhoid fever. In both diseases, therefore, the problem of dissemination is reduced to this: How may the discharges from the bowels of patients affected with cholera or typhoid fever be conveyed to the mouths of other people; or, reducing the problem to its lowest terms, How may the

bowel discharges of A reach the mouth of B. The answer to this question should give us, and in fact does give us, the basis of a rational procedure in prevention.

We may stop at this point long enough to observe that if what has been said is true—and I have no hesitation in affirming most emphatically that it is—the recent extraordinary exhibition of popular alarm in this country was most discreditable. If there was any reason for it, that reason must have been a distrust of our capacity to keep bowel discharges out of the mouths of the people. If there was no reason for it, it was a shameful exhibition of cowardice. It ought to be distinctly understood that the recent cholera “scare” was a national discredit—discreditable if it was needless, more discreditable if it was necessary.

If we seek to discover how the bowel discharges of A may reach the mouth of B, we shall not have far to look. It is well worth our while to do this, for scientific prevention of disease must be based upon and guided by detailed knowledge of the ways in which disease is disseminated.

If by food we understand, as we may, both solids and liquids, such as bread and water, we may safely affirm that the commonest carriers of diarrhoeal diseases, such as typhoid fever and Asiatic cholera, are undoubtedly *food and fingers*. Food may become contaminated by fingers, and fingers are only too easily contaminated by bowel discharges. I do not need to specify all the details, but every one knows how that most convenient organ, the human hand—the hand of the patient, the hand of the doctor, the hand of the nurse, the hand of the servant—may only too easily become fouled and contaminated with particles of excreta. Once this has happened it requires only a little carelessness, a little neglect, with no washing or with only imperfect or hasty washing, to leave the deadly particles upon the fingers, from which they may be rubbed off upon a loaf of bread, or fall into a pail of milk or rest upon a peach. From my experience with typhoid fever I am persuaded that in dealing with filth we are too apt to think of the more conspicuous public filth, and to forget the private and often invisible personal filth. It is of small avail to clean the streets of a city if typhoid or cholera patients continue to act as servants, cutting bread or handling fruit for others to eat, with fingers imperfectly cleaned.

I have perhaps said enough of solid food and fingers as agents or carriers of infection from diarrhoeal diseases; but to show how disas-

trous such contamination may be when it extends to liquid foods like milk and water I may give an illustration by describing briefly one or two epidemics of typhoid fever due to infected milk, and a cholera epidemic due to an infected public water supply. There recently appeared among some of the best families in one of the best wards of a city of Massachusetts an epidemic of typhoid fever. The district was on high land, admirably drained and perfectly sewered. The public water supply was above suspicion, and was shared by all of the uninfected parts of the city in common with this district. Various vague theories were proposed to account for the disease. Some looked for the cause in a cemetery hard by; some pointed with positiveness to the well waters used by some of the families; some spoke of pestilence in the air, but failed to explain why the air in this region alone was pestilential. The State Board of Health, coöperating with the local board, made a careful inquiry, and found that the milk supply of this particular part of the city was infected; and the probable manner of infection was this:

In the family of the farmer who supplied the milk there had been typhoid fever. The excreta of the patients had been thrown into the privy. The contents of the privy had been spread upon a tobacco field. The cans of milk, after being nearly but not entirely filled, were submerged in a well in order to keep the milk cool and thus avoid the cost of ice. They were stoppered with wooden plugs, which were driven in hard. Nevertheless there was every reason to believe that the germs of typhoid fever had traveled from the tobacco field into the milk cans, and in the following manner: There was positive proof that in spite of the plugs the cans leaked around and through them; for on drawing up the cans and inverting them nearly one half of them were found to be leaking so much that drops of milk, and in some cases a stream of milk, ran out. But if milk could run out of cans thus stoppered, water could run in; and there was abundant evidence that it had so run in. It only remained to show how the well might have got infected. This well, however, was the only convenient source of cold water on the farm. It was a large well, covered with an old platform made of worn planks between which were wide cracks. There was one hole, two or three inches in diameter, in the platform. Pieces of manure were observed on the planks about to fall into the well. The curb was on one side, and the overflow water mostly fell upon the platform and ran back into the well, carrying with

it whatever lay on the planks near it. To this well, from the tobacco field, in rain or shine, with dry boots or wet, the men came for water or to attend to the milk. It was not proved that they had ever brought typhoid fæces from the field upon their boots, but there was reason to believe that they had done so, and had thus contaminated the well, while from the well the germs had leaked with the water into the milk.

In this way the bowel discharges probably passed from the patients on the lonely farm to the tables of the victims in the city. If the disease had been cholera instead of typhoid fever there would have been more deaths, but most of the phenomena would have been the same. If it had been cholera the whole country would have been in an uproar. But as it was "only" typhoid fever the dead were buried, the wounded have recovered and nothing more is heard of the "accident." In all twenty-five were killed and one hundred and thirty-five were wounded.

In another case, in a suburb of Boston, typhoid fever broke out among some of the best families. Four persons were killed and thirty were wounded. This "attack," also, was traced to infected milk, one of the milkmen himself having had the disease, and while suffering from diarrhoea having in all probability contaminated the milk at his central establishment.

I have said enough to show how milk, one of the most important and universally employed of food materials, may serve as a vehicle for diarrhoeal diseases, such as Asiatic cholera and typhoid fever. A similar and equally instructive series of phenomena is true of drinking water. Here we have an excellent modern instance in the experience of the city of Genoa, Italy, in 1884. Cholera had appeared in Spezia, some fifty miles away; but after cholera had been raging in Southern Europe nearly two months Consul Fletcher of Genoa wrote to the authorities in Washington: "I do not believe the officials in any city in Europe could be more watchful or take more extreme precautions to ward off the epidemic than those in authority in Genoa. The result is that Genoa is in as healthy a state to-day as it is possible for human agency to make it, considering its peculiar construction and its proximity to the sea." The cholera was then but fifty miles distant; but for a month later the city retained its healthfulness, when suddenly the cholera appeared, and in one week one hundred and sixty-nine people died with this disease, nine tenths of whom were supplied by one of the three public water supplies of the city.

Upon investigation it was found that upon the stream which was the source of this water supply, thirteen miles from the city, between one thousand five hundred and two thousand laborers were at work upon a railroad, and in the previous week cholera had broken out among them. They washed their clothes in this stream, and some of their bowel discharges probably also found their way into it. On the tenth day after the cholera appeared in Genoa this source of water supply was cut off, and the portion of the city which it served was supplied from one of the other sources. The daily deaths from cholera immediately decreased, and in six days the number had fallen from thirty-eight to ten. The whole number of cases in the sections of the city supplied by the polluted water was four hundred and forty-four, and in the two sections supplied by public water supplies of unpolluted water the whole number was fifty-five.

In the autumn of 1890 the cities of Lowell and Lawrence suffered severely from an extensive epidemic of typhoid fever. The record of this unfortunate affair was not far from one hundred killed and one thousand wounded. The source of the disease was found to be discharges from the bowels of typhoid patients on a feeder of the water supply only a little more than two miles above the in-take of the Lowell waterworks. The journey of the germs from the bowels to the mouth was here perfectly evident.

I might extend almost indefinitely illustrations of this kind, showing how intricate, and yet how clear, the passage of germs from the intestine of A to the mouth of B often is, when food and fingers combine, or when food or drink become directly contaminated by sewage. The one indispensable requisite obviously is to *avoid the contamination of food and fingers*. It is probably safe to say that if the bowel discharges of the patients and the fingers of those who have to deal with cholera patients are properly disinfected all danger can be avoided and the disease confined strictly to its original appearance. The recent experience of New York City should teach us how foolish and unnecessary is any feeling of general alarm for those who have good water, good milk, clean servants and the other attributes of good living. It may be difficult to secure these; it certainly often is difficult, and for many it is at present impossible. But allowing that we should be most solicitous over these things let us not forget that the disease can be held in check by isolation and disinfection. If boards of health and other public functionaries do their duty; if every case that

appears is promptly and effectively isolated; if disinfection of the bowel discharges is thorough — in short, if the subject is treated in a scrupulously scientific manner the danger for well regulated communities can easily be reduced to a very small quantity.¹

The citizens of Philadelphia, Chicago, Lowell, Lawrence and Albany on the other hand may reasonably feel much concerned about cholera, for their very large annual death rates from typhoid fever testify to the presence of bowel discharges in their supplies of drinking water. It is not generally known that the death rates from typhoid fever in Philadelphia and Chicago are and have long been more than twice as great as is that of Hamburg; so that there would be just cause for alarm in these cities if cholera should appear in America and should approach their water supplies.

All that I have said bears upon the question of quarantine. Isolation of patients, with disinfection of excreta, etc., we obviously must have. But quarantine such as we have recently seen in New York is in my opinion unnecessary and dangerous. In spite of it cholera got into New York, and while very likely more of it would have got in without the quarantine it is certain to my mind that it could and would have been as effectually suppressed as the smaller quantity was, and with less general suffering and alarm than the harbor quarantine as conducted produced. The community¹ has it in its power at any time to suppress diarrhoeal diseases if it will only isolate and disinfect, and it makes but little difference whether the disease is typhoid fever or Asiatic cholera.

For cities having polluted food and drink, or filthy ways of living, prolonged public or general quarantine is a desperate attempt at self-protection. For communities in good sanitary condition it is antiquated and clumsy.

Pettenkofer has given the key to the whole situation by saying that filth is like gunpowder, for which cholera is a spark. A community had better remove the gunpowder than try to beat off the spark; for in spite of their efforts, however frantic, this may at any time reach the powder and if it does is sure to blow them to pieces.

¹ It is worth remembering that although about 18,000 persons in Hamburg had cholera in the recent epidemic about 604,500 of the inhabitants escaped. In the Lowell epidemic of typhoid fever 77,000 persons out of 78,000 remained unaffected. In other words only $\frac{1}{8}$ of the people in Hamburg had cholera, while $\frac{3}{4}$ escaped. In Lowell $\frac{1}{8}$ had typhoid fever and $\frac{7}{8}$ escaped.